The Energy Commission's Natural Gas Vehicle Research Roadmap

NGV Technology Forum
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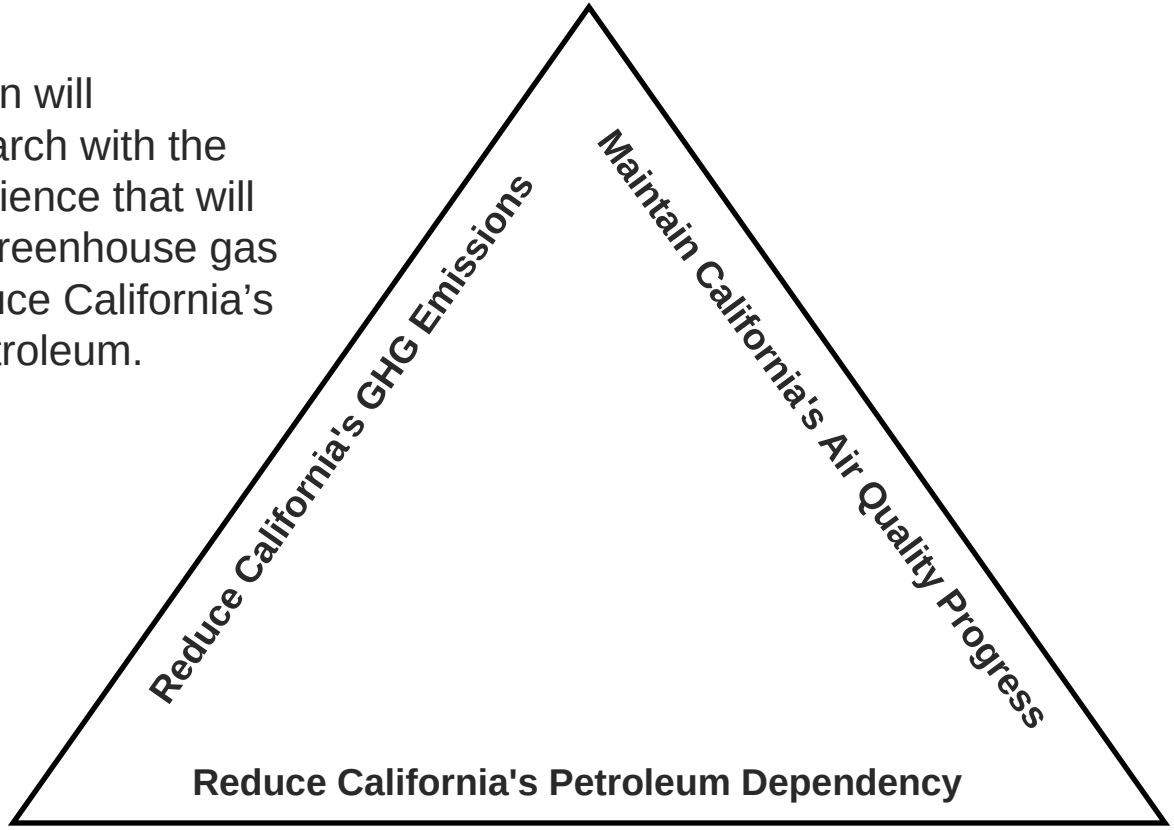
Transportation Research will Interlock Greenhouse Gas Reduction, Petroleum Reduction and Air Quality

PIER Transportation will coordinate its research with the ARB to advance science that will lower California's greenhouse gas emissions and reduce California's dependence on petroleum.



Transportation Research Focus Areas

Vehicle Technologies

- Plug-in Electric Hybrids
- Natural Gas Vehicles
- Vehicle Lightweighting
- Energy-efficiency - active components
- Energy efficiency – passive components

Alternative Fuels

- Investigate expanded range of biofuel production opportunities
- Improve energy and environmental performance of biofuel process technologies
- Demonstrate technical viability of expanded biofuel blends with conventional fuels within existing infrastructure

Transportation Systems

- Transportation energy in sustainable communities
- Electricity as Fuel
- Goods movement
- LCA Tools and Methods

Transportation Research Roadmaps are in Progress

Natural Gas Vehicles: Complete

Alternative Fuels: Completion 2nd Quarter ‘09

Plug-in Hybrid Electric Vehicles: Completion 1st Quarter, ‘09

Vehicle Sub-system Efficiency: Completion 1st Quarter, ‘09

Research Roadmaps Define Opportunities, Direction, Priorities

Roadmap Objectives

- Relative to selected issues, identify gaps in ongoing research
- Facilitate collaborations with other research institutions, state agencies, and utilities
- Define short-, mid-, and long-term goals, timeframes, budgets, and activities
- Balance timeframes, risk, and provide the greatest public benefit
- Define success metrics

NGVs: Ready Fuel, Limited Takers

The State Alternative Fuels Plan notes that "…Natural gas use in heavy-duty vehicles alone could represent about 36 percent of the freight and off-road vehicle fuel use by 2050."

But, the NGV research roadmap notes

- "…a lack of heavy-duty and off-road engine sizes/capacity…" and,
- Vehicle integration is a significant hurdle to greater NGV availability and market penetration

Table 4: Maximum Feasible Alternative Fuel Use Results By Fuel

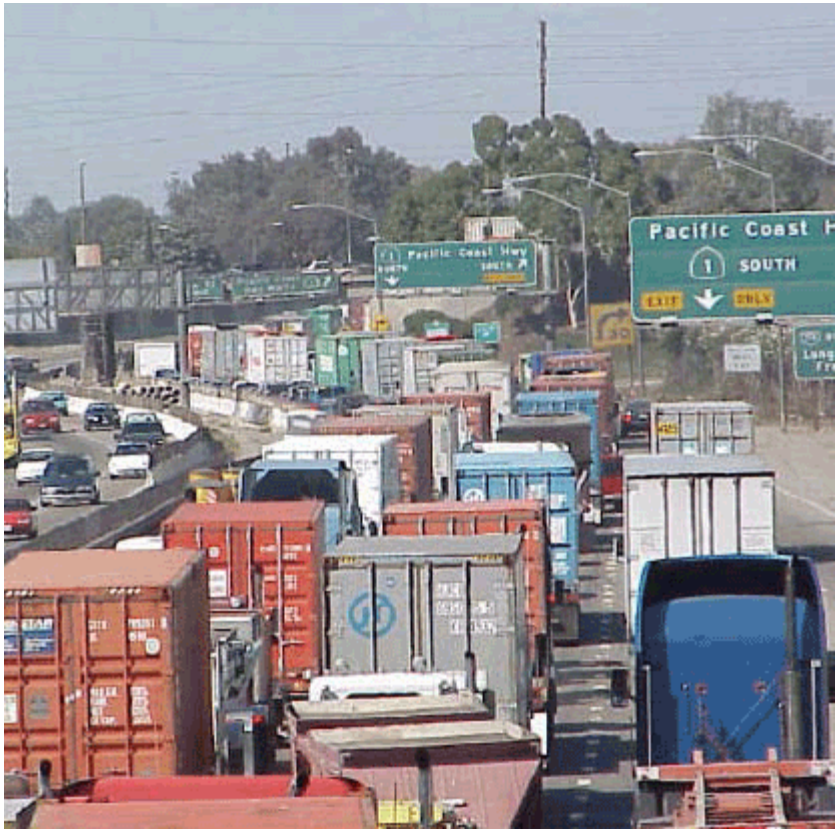
Mile Stone Year	2012		2017		2022	
	Fuel Use	GHG	Fuel Use	GHG	Fuel Use	GHG
Propane	48	<0.1	173	0.1	282	0.2
Natural Gas	306	1.5	518	2.5	885	4.4
E10 (MW Corn)	1394	3.8	1354	3.8	1327	3.6
E85 (CA Poplar)	83	0.7	434	3.9	738	6.6
Hydrogen	40	0.3	80	0.6	440	4.4
Electricity	86	2.1	187	5.1	376	6.7
GTL, CTL, and PTL[20]	320	0	530	0	630	0
Renewable Diesel	130	1	310	2.4	530	4.2
Dimethyl Ether	13	0	62	0	101	0
Total	**2420**	**10**	**3648**	**18**	**5309**	**30**

Fuel use measured in million gasoline gallon equivalent. For hydrogen and electricity, the petroleum displacement is greater than the fuel used due to the vehicle efficiency.
GHG measured in million metric tons per year.

The NGV Research Roadmap's Development Path

		Top Priorities	Second-Tier Priorities	Longer-Term Priorities
Near Term	Engine Development and Vehicle Integration	More heavy- and medium-duty engine/vehicle integration	More line haul heavy-duty engine/vehicle choices	Light-duty vehicle choice expansion
		More heavy-duty and medium-duty engine sizes	Certification of new models	Continued engine refinements
		Existing heavy-duty and medium-duty engine improvements		HCNG and HCCI engines/verifications
Longer-Term			Determine and develop the controls for emissions due to fuel variability and stricter GHG (i.e., methane) standards.	
Near Term	Fueling Infrastructure and Storage	Develop legacy fleet engine controls and/or repower/retire programs to accommodate fuel variability		
		Fueling ease/standards for CNG and LNG	GPS-based station locator/information portal	
			On-board fuel tank economies	Low-pressure on-board fuel storage
Longer-Term		Fueling station economics	Modular fueling stations	Non-traditional station sites
Near Term	Technical and Strategic Studies	CNG & LNG vehicle database	Codes and protocol studies/changes	
		Fleet business case models	Public station economies	Insurance economies
Longer-Term		Technical roadmap update panel		

New NGV Engines will Promote Broader Applications



Project: Advanced, Heavy-Duty 0.20 g/bhp-hr NOx LNG HPDI Engine

- $500,000 PIER funding with $9 million in match funding to demonstrate the Westport LNG HPDI engine in heavy duty truck applications
- Emissions equal to or better than 2010 clean diesel
- Substantial reduction in emissions for Ports of Long Beach and LA
- Partners include ARB and SCAQMD

PIER Transportation Technology Research Planning and Results will Target ARFVT (AB 118) Implementation

PIER transportation will fill a technology pipeline for commercial implementation through the ARFVT

- Coordination with ARFVT annual investment plans
- Must tie in with transportation energy policy (IEPR)

NREL and NGVTF will assist New Technology Implementation

- Resources, data, and input from key stakeholders critical to successful implementation of the NGVRR
- Research partnership with NREL
- The research will identify the highest value current and future RDD&D efforts required to build a sustainable NGV market within California.
- NREL will provide research and analysis to support engine development and vehicle integration, fueling infrastructure and storage RDD&D projects identified in the PIER Transportation Natural Gas Vehicle Research Roadmap (NGVRR)

Planned PIER Transportation Solicitations

Solicitation	Purpose	Type	Amount	Release
Natural Gas Engine Development	Increase efficiency and reduce emissions in HD engines	Grant	$2 million	10/08
Direct Biosynthesis of Alternative Fuels	Develop processes for direct biosynthesis of renewable fuels	Grant	$1.25 million	10/8
CHP Applications of Heavy Duty Truck Engines*	Advance technologies that provide co-benefits to heavy duty vehicles used in both on- and off-road transportation	Grant	$1 million	9/08
Characterization and Purification of Digester Biogas**	Develop biogas cleanup technologies to enable the use of biogas as a transportation fuel	Grant	$1 million	9/08

*Co-funded solicitation with PIER EPAG Subject Area

**Co-funded solicitation with PIER Renewables Subject Area

Competitive Grant Solicitation

Advanced Heavy-Duty Natural Gas Engine Research & Development

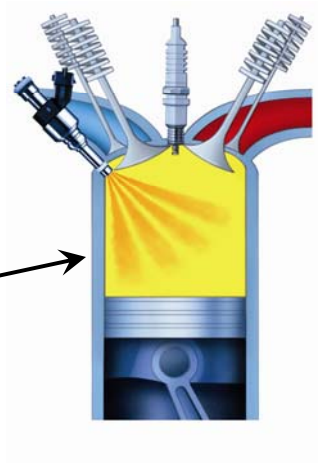
PIER Transportation Vehicle Technology Focus Area

Purpose of Solicitation

- Accelerate R&D of advanced natural gas engine concepts for application in heavy-duty vehicles.
- RD&D is needed to improve the operating efficiency and power output of heavy duty natural gas engines.
- Natural gas (both CNG and LNG) offers good near-term potential to serve a larger share of the vehicle market if certain performance and technical barriers can be overcome.
    - Analysis in the State Alternative Fuels Plan shows a high potential for Natural Gas to reduce GHG (11-23%), however a loss of efficiency detracts from beneficial market expansion.

Eligible Projects

- Promising technologies that improve fuel efficiency and may also improve the power density of heavy-duty natural gas engines - through new advances in combustion and/or engine control technologies.
- Candidate concepts include (but are not limited to):
  - cylinder deactivation
  - advanced controls
  - multi-port injection
  - direct injection
  - combustion chamber optimization
  - cool-combustion technologies



Eligible projects should seek to maximize realized benefits

- Targeting engines for OEM vehicle applications that have a significant presence in California fleets
- Targeting high fuel use heavy-duty fleet applications and market sectors, both on-road and non-road
- Proposing concepts that offer significant reduction in fuel consumption relative to conventional NGV heavy-duty engines
- Proposing technologies that can be broadly applied to different heavy-duty NGV engines, with a variety of power levels, and implemented into a variety of vehicle applications.
- Providing market-competitive driving characteristics, without performance compromises
- Exceeding applicable ARB heavy-duty on-road emission requirements
- Proposed research projects must include:
  - development and prototype testing of advanced concepts for later product development
  - the development of engine components and systems for near-term market introduction.

Eligible Applicant Requirements

- This is a competitive solicitation seeking technology developers and teams who have demonstrated expertise and experience with the development of advanced engine concepts, control systems, and products.

- To be eligible applicants must present a team with demonstrated development, testing, and commercialization capabilities.

- Both private and public entities may apply.

Funding Information and Schedule of Proposal and Awards

- A total of up to **$2 Million** is available for PIER project funding through this solicitation.
- The Energy Commission anticipates selecting two to three projects for funding as grants.
- No single applicant may request funding for more than $1,000,000.
- This solicitation requires match funding which should be appropriate and consistent with the expected level of public versus private benefits accrued from the project.

Release of Program Notice	
First Pre-Proposal Workshop	
Second Pre-Proposal Workshop, via WebEx only	
Deadline to Submit Proposals	
Post Notice of Proposed Awards	April 2009 (*Estimated)*
Approval of Awards at Energy Commission	May – June 2009 (*Estimated)*

Thank You!

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